Trimeresurus flavomaculatus, Gray.

(= *Megæra ornata*, Gray, = *Megæra variegata*, Gray.)

Placer.

The ground-colour varies; one specimen is purplish brown, with darker cross bars, and with a series of salmon-coloured spots along each side of the belly.

Frogs.

Rana tigrina, Daud.

Surigao. [Laguna del Bay.]

Rana macrodon, Kuhl.

Dinagat Island. [Negros, Laguna del Bay.]

Megalophrys montana, Kuhl.

Dinagat Island.

Ixalus natator, Gthr.

Dinagat Island.

Polypedates appendiculatus, Gthr.

Dinagat Island.

Rhacophorus pardalis, Gthr.

Dinagat Island.

Platymantis meyeri, Gthr.

Dinagat Island. [Laguna del Bay.]

7. On the Anatomy of *Hyæna crocuta* (*H. maculata*). By Morrison Watson, M.D., and Alfred H. Young, M.B., of The Owens College, Manchester. Communicated by A. H. Garrod.

[Received November 15, 1878.]

(Plates V., VI.)

The remarkable and unique characters of the generative organs of *Hyæna crocuta*, accounts of which have formed the subject matter of two previous communications to this Society[1], suggested the advisability of investigating the general anatomical features of this species with a view to future comparison. In the meantime, as nothing like a comprehensive or detailed description of the anatomy of the Spotted Hyæna has hitherto been given, and as that of other members of the same genus is incomplete and exists only in a scattered form, we have thought that the record of our observations on this subject might be of use. That it might prove so we have endeavoured to ensure by making our descriptions as complete as

[1] Watson, Proc. Zool. Soc. May 1877, and April 1878.

possible, supplementing these where it has been deemed expedient by illustrations sketched from recent dissections. Necessarily this course of procedure, especially as applied to the muscles, entails somewhat lengthy accounts. This doubtless, from some points of view, is objectionable; we have preferred to adopt it, however, rather than refer to groups of structures as being "arranged in the usual manner," a system of recording observations which, however satisfactory to the author, frequently renders a paper utterly useless to subsequent workers.

So far as the records of the older writers (notably Herodotus[1], Aristotle[2], Pliny[3], and Ælian[4]) attest, their observations on the genus *Hyæna* are practically limited to a consideration of the external features and sexual peculiarities—a misconception having existed on this latter point, which has extended to the present time.

Beyond this their writings are almost entirely confined to lengthy accounts of the various superstitions respecting the Hyæna and certain of its individual parts. Of all these a fair summary is to be found in Topsel's collection from the writings of Gesner and others[5]. Here also the hermaphroditic nature of the species is referred to and denied.

Subsequently to this time, as might naturally be expected in the case of so common and familiar a Carnivore, the detailed anatomy of the genus has received more or less attention at the hands of various observers. Except in so far as the osseous system is concerned, however, it is somewhat astonishing to find that the record of their work which constitutes the modern literature concerning *Hyæna*, refers only (*i. e.* when the species is definitely stated) to *H. striata* or to *H. brunnea*, the Spotted Hyæna having apparently thus far enjoyed almost a total immunity from the scalpel.

We would specially indicate here, as embodying the greater part of what is known regarding the soft parts of the former species, that descriptive accounts of the visceral organs have been given by Reimann[6], Rudolphi, Daubenton[7], and Hunter[8], whilst Meckel[9] and Cuvier[10], who also seem in the main to have limited their observations to this species, refer not only to the viscera, but also to the muscular arrangements, Meckel further making isolated references to the viscera of *H. crocuta*. The muscles of *H striata* are fully illustrated, in plates 129–142 of Cuvier and Laurillard's 'Myology'[11]. Respecting *H. brunnea*, Dr. Murie[12] has contributed a paper on the viscera and female generative organs, and indicated some of the characteristic myological features of the species.

[1] Rawlinson's Herodotus, vol. iii.
[2] Historia Animalium, vi.
[3] Pliny, viii.
[4] Historia Animalium, i.
[5] The History of Four-footed Beasts and Serpents, collected out of the writings of Conradus Gesner and other writers, by Ed. Topsel, 1658, p. 339.
[6] De Hyæna, Berol. 1811.
[7] Buffon, Histoire Naturelle, tome ix.
[8] Essays and Observations, edit. by Owen, 1861, vol. ii.
[9] Anatomie Comparée.
[10] Leçons d'Anat. Comp.
[11] Recueil de Planches de Myologie.
[12] Trans. Zool. Soc. Lond., vol. vii. p. 503.

The animal from which the following observations have been compiled was a well-developed male. It came into our possession shortly after death, in excellent condition for dissecting-purposes.

Viscera.

Digestive Organs.

Tongue.—The tongue conforms to the Carnivorous type of the organ, being elongated, flattened, and thin. The filiform papillæ covering the whole of the dorsal surface and margins are of large size, and present the appearence of small recurved spines. One inch behind the tip these papillæ are somewhat modified in form, and are arranged in a clearly defined oval patch. In this region each papilla is situated on a broad conical base, and terminates in a blunt truncated extremity, which contrasts strongly with the sharp recurved appearance of these papillæ upon other parts of the organ. This patch is referred to by Owen[1], in his description of the tongue in the genus *Hyæna*, but without particularizing the species. Interspersed among the filiform papillæ, over the entire surface of the tongue, and almost concealed by them, are numerous minute fungiform papillæ of a white colour and devoid of spines. The circumvallate papillæ are two in number, of small size. They are situated close to the root of the tongue, one on either side of the middle line. With regard to the number of these structures, our observations agree with those of Meckel[2] and Rudolphi[3], and differ from those of Daubenton[4], according to whom they are four in number. As, however, the specimen examined by the latter author belonged to the species *H. striata*, this may account for the difference of statement. Meckel does not particularize the species which he examined, though probably it was *H. striata*. Behind the circumvallate papillæ, those of the filiform variety are of larger size than elsewhere, and differ in being soft and devoid of the spiny character which distinguishes those placed more anteriorly. The tongue of the Spotted Hyæna, both as regards its form and the arrangement of its papillæ, agrees closely with that of *H. striata* and of *Proteles*[5]. In all of these we recognize the patch of truncated filiform papillæ near the tip; at the same time it is to be observed that this is not a distinctive feature in the anatomy of these animals, a somewhat similar appearance being recognizable in the tongues of certain of the true Felidæ. This patch in *Proteles* corresponds to the anterior third of the tongue; but in both *H. crocuta* and *H. striata* it is confined to the central region of the tip, and does not extend to the margins of the organ. In the Civet, the tongue of which in other respects closely resembles that of *Hyæna*, this patch is absent.

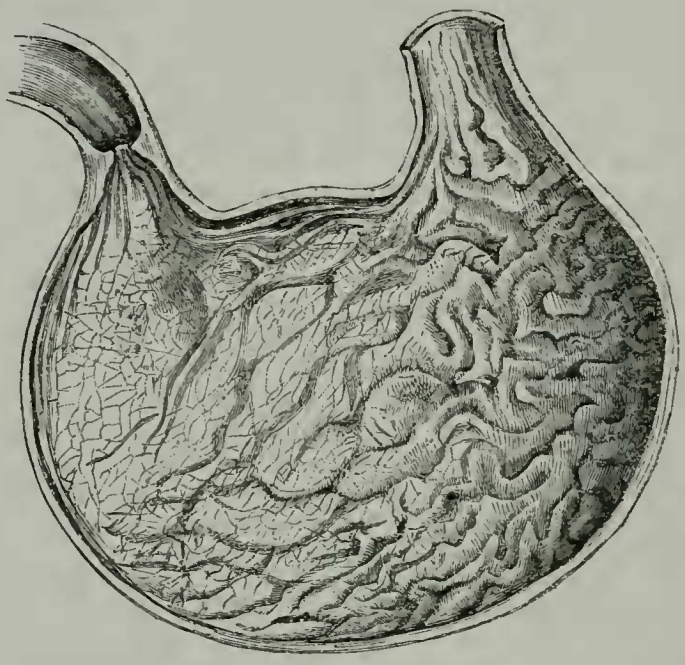
The tonsil is of considerable size, oval in form, and consists of a number of obliquely placed glandular ridges. It closely resembles the

[1] Anatomy of Vertebrates, vol. iii. p. 198.
[2] Anatomie Comparée, vol. viii. p. 685.
[3] Reimann, De Hyæna, Berol. 1811, p. 15.
[4] Buffon, Histoire Naturelle, vol. ix. p. 129.
[5] Prof. Flower, Proc. Zool. Soc. 1869, p. 474.

corresponding organ in *Proteles*[1]. The soft palate is short, and presents no trace of uvula, such being the case likewise in *Proteles*. The œsophagus, as noted by Meckel[2] in the specimen examined by him, is wide and dilatable. Its muscular walls are very thick, as is also the mucous coat, the latter being dense, tough, and thrown into longitudinal rugæ.

Stomach.—The stomach is short and rounded, and corresponds exactly as regards form with the description given by Daubenton[3] and Murie[4] of that organ in *H. striata*[5] and *H. brunnea* respectively, and by Professor Flower[6] in his observations on *Proteles*. When emptied of its contents, it measures 9 inches in length and 7 inches

Fig. 1.



Stomach of *Hyæna crocuta*, laid open to show character of the mucous membrane.

in greatest breadth. The œsophagus enters the small curvature close to the left extremity; and in consequence the great end or fundus of the stomach is extremely shallow. The greater curvature presents a slight constriction close to the pyloric extemity, similar to that noticed by Prof. Flower in *Proteles*. The walls are thick and muscular, as in *H. brunnea* and *Proteles*. Dr. Murie recognized in the former a central tendon, from which the muscular fibres

[1] Prof. Flower, Proc. Zool. Soc. 1869, p. 474.
[2] *Loc. cit.*
[3] *Loc. cit.*
[4] Trans. Zool. Soc. vol. vii. p. 503.
[5] The stomach of *H. striata* is figured in the 'Erläuterungstafeln zur vergleichenden Anatomie' of C. G. Carus.
[6] Proc. Zool. Soc. 1869.

radiated somewhat after the manner observed in the gizzard of a bird; and the same appearance is noticeable in our specimen. This tendinous arragement, however, is confined to the surface of the organ, and does not extend into the wall. Professor Flower, in accordance with differences in appearance of its mucous membrane, describes three distinct portions of the stomach in *Proteles*; and a similar subdivision may be adopted in describing that of *Hyæna crocuta*. In the first, or cardiac portion of the organ, the mucous membrane is thrown into well-marked rugæ, which are not arranged in any regular manner, but, uniting at various points with one another, give rise to a convoluted appearance somewhat resembling the gyri of the cerebrum. They are more irregularly disposed at the entrance of the œsophagus than elsewhere, and are here continuous with the longitudinal rugæ of that tube. In respect of the rugose character of this portion of the gastric mucous membrane, *H. crocuta* differs from *Proteles*, in the stomach of which these rugæ are absent. Corresponding to the middle third of the stomach, the mucous membrane is thrown into rugæ of larger size than elsewhere. These rugæ lie parallel to the long axis of the organ, and are united here and there by means of smaller transverse folds. Along the great curvature the large longitudinal folds are better marked than on the small curvature of the stomach. The mucous membrane of the duodenal third of the stomach is less rugose than that of any other portion, such rugæ as are present being found in relation to the curvatures of the organ, whilst the anterior and posterior walls of the stomach are quite smooth. Every portion of the gastric mucous membrane in the intervals of the larger rugæ presents a delicate reticulate and glandular appearence. The pyloric orifice is extremely small, and in the specimen examined measured only $\frac{1}{8}$ of an inch in diameter. The valve is annular in form, and not crescentic as in *Proteles*. It will be seen from what has been said, that, in respect of the form and character of the stomach, but little difference is observable between the three species of *Hyæna* when they are compared with one another or with *Proteles*.

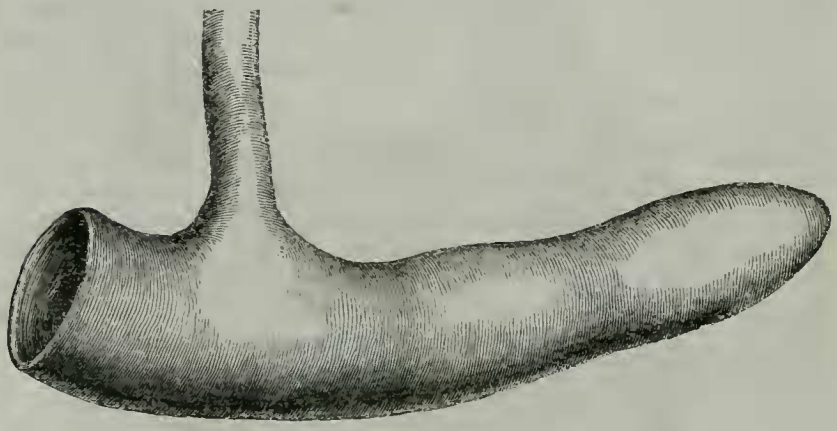
Small Intestine.—This portion of the gut measures 32 feet 6 inches in length. Its diameter is not uniform, but presents a number of constrictions, which are distributed at irregular intervals along its entire course. As a rule it measures about one inch in diameter; but where constrictions occur it does not exceed half an inch. Throughout its course its mucous membrane is covered with villi. The Peyerian patches are eight in number, and vary much in size, the smaller being found towards the commencement of the intestine, whilst the largest, which measured 9 inches in length, was situated toward the lower end of the ileum. It is worthy of note that in *Proteles* the number of these patches is the same as in *H. crocuta*. In *H. striata*, according to Meckel[1], they do not exceed twelve in number.

Great intestine.—The cæcum measures 6 inches in length, and agrees closely as regards its form with that figured by Daubenton in *H. striata*. In the latter species, according to the author named,

[1] *Loc. cit.* p. 706.

it measured 9 inches in length—according to Reimann, 6 inches. In *H. brunnea* it is $8\frac{1}{2}$ inches long, whilst in *Proteles* it is short and globular, measuring only one inch in length. The large intestine exclusive of cæcum measures $26\frac{1}{2}$ inches, and is provided with thick muscular walls. In *H. striata* the great gut measures 3 feet, and in *H. brunnea* 2 feet 6 inches in length, whilst in *Proteles*, exclusive of the cæcum, it measures 14 inches. In connexion with the lower end of the rectum are two anal glands, which pour their contents into a pouch situated immediately above the anus. These glands, which have been previously described[1], resemble more closely, both in respect of number and size, the corresponding structures in *Proteles* than those of any other species of *Hyæna*.

Fig. 2.



Cæcum of *Hyæna crocuta*.

The following Table shows the length of the intestines, together with that of the body, in the different species of *Hyæna*; but it is right to state, with reference to the latter measurement of *H. crocuta*, that we have taken it to be the same as in *H. brunnea*, having unfortunately omitted to ascertain the dimensions of the specimen examined; the measurements of the other species are those of Daubenton, Murie, and Flower respectively.

	H. striata. ft. in.	*H. brunnea.* ft. in.	*H. crocuta.* ft. in.	*Proteles cristatus.* ft. in.
Length of body from nose to anus	3 2	3 9	3 9	2 3
Small intestine	23 0	26 7	32 6	9 6
Great intestine	3 9	3 $3\frac{1}{2}$	2 8	1 3

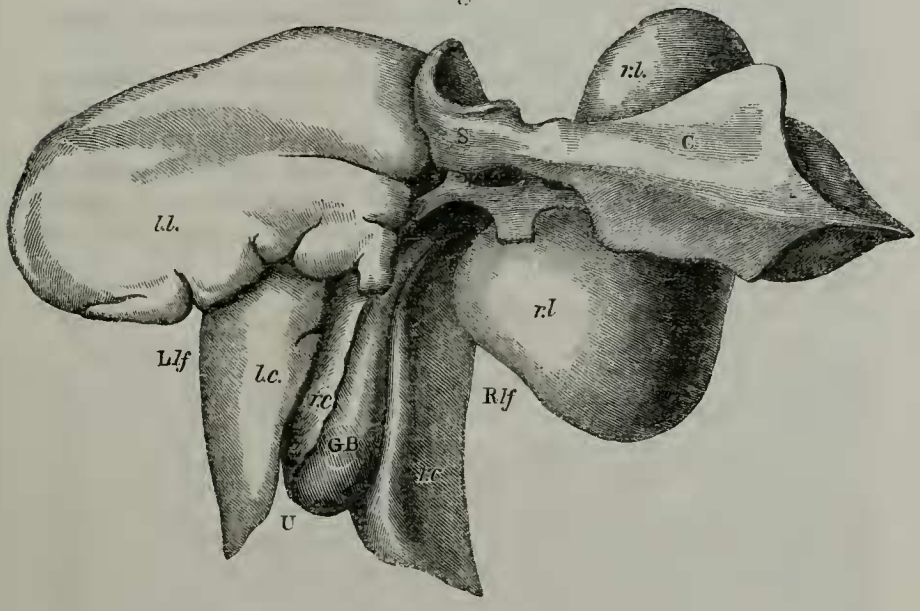
From this table it appears that in *H. striata* the length of the whole intestine from pylorus to anus is to that of the body as 8 to 1,

[1] Proc. Zool. Soc. May, 1877.

in *H. brunnea* as 8 to 1, in *Proteles* as 5 to 1, and in *H. crocuta* as more than 9 to 1. With reference to the relative lengths of the small and great intestines, the table shows that in *H. striata* the length of the small intestine is to that of the great as $6\frac{1}{7}$ to 1, in *H. brunnea* as $8\frac{1}{5}$ to 1, in *Proteles* as $7\frac{3}{5}$ to 1, and in *H. crocuta* as $12\frac{1}{5}$ to 1. *H. crocuta* therefore differs from the other species named in the greater length of the small intestine as compared not only with that of the body, but also with that of the great intestine.

Liver.—The liver is large. In accordance with Prof. Flower's[1] method of description, we distinguish two hepatic segments, a right and a left, each of which is divided into lobes. The *left* segment is the smaller, and is divided, by means of a well-marked lateral fissure, into a lateral and a central lobe. Of these the former is much the larger and of an oval form, whilst the latter is triangular, with the apex directed backward. The *right* segment of the liver, larger

Fig. 3.



Liver of *Hyæna crocuta*.

U, umbilical fissure; *Llf*, left lateral fissure; *Rlf*, right lateral fissure; *l.l*, left lateral. and *l.c*, left central lobe; *r.l*, right lateral, and *r.c*, right central lobe; *S*, Spigelian lobe; *C*, caudate lobe; *G.B*, gall-bladder.

than the left, also presents a well-marked lateral fissure, by means of which the right central is cut off from the right lateral lobe. On the visceral aspect of the former is a deep cystic fissure which accommodates the gall-bladder, and divides the central lobe into

[1] Medical Times and Gazette, vol. i. 1872, p. 293.

two parts—a smaller, lying to the left, and a larger irregularly quadrilateral mass, which lies to the right of the gall-bladder. The right hepatic segment, moreover, presents well-marked Spigelian and caudate lobes. These are quite continuous with each other, and extend along the posterior margin of the transverse or portal fissure.

The gall-bladder, situated on the right central lobe, is of large size and regularly pyriform. The cystic duct is 1½ inch in length, and unites with the left hepatic duct, which, after a farther course of half an inch receives the right hepatic duct. The common bile-duct, formed as described, enters the duodenum along with the duct of the pancreas.

In respect of the liver, *H. crocuta* agrees closely with *H. striata* and *H. brunnea*, differing from the former, however, in the absence of the sharp curvature of the neck of the gall-bladder described by Daubenton[1], and referred to by Meckel[2]. The resembance of this viscus to that of *Proteles* is no less striking, the only difference between them consisting in the more complete separation of the lobes in *H. crocuta* than in *Proteles*.

Pancreas.—Measures one foot in length, and has an average breadth of one inch. It occupies the usual position.

Spleen.—Elongated and tongue-shaped, measures 16 inches in length; its borders are very irregular, but without distinct fissures. Its widest portion is 3, and its narrowest 1 inch in breadth. These measurements correspond closely with those of the organ in other species of *Hyæna*. The viscus differs from that of *Proteles*[3] only in its larger size and in the absence of any oblique fissure on its outer surface.

Larynx and Respiratory Organs.

Larynx.—The superior aperture of the larynx is guarded by an epiglottis of large size; its posterior surface is deeply concave, and its apex uniformly rounded. In respect of its form this structure resembles much more closely that of the Felidæ than of the Canidæ, in the latter of which it is distinctly triangular and almost flat. The thyroid cartilage is wide, and, as observed by Prof. Flower in *Proteles*, destitute of a fissure on its lower margin. It differs from the thyroid cartilage in both Felidæ and Canidæ in the much greater projection of its anterior tubercle. The cricoid cartilage is of the same general form as in *Proteles*, differing from the latter, however, inasmuch as its upper border posteriorly is not prolonged into a median pointed spine. In consequence of this the arytænoid cartilages extend beyond the highest point of the cricoid, and are not situated below the level of its posterior median spine as is the case in *Proteles*. The false vocal cords (which, according to Mayer[4], are absent in *H. striata*) are rounded and soft, and are placed very obliquely between the arytænoid and thyroid cartilages, their anterior extremities being

[1] *Loc. cit.* [2] *Op. cit.* vol. viii. p. 720.

[3] Prof. Flower, *loc. cit.*

[4] "Ueber den Bau des Organes der Stimme," Nova Acta Acad. Naturæ-Curios. vol. xxiii. 1851, p. 694.

placed higher in the laryngeal box than the posterior. They are (as is the case also in *Proteles*) separated from the base of the epiglottis in front and from the arytæno-epiglottidean folds of mucous membrane of each side by a deep sinus, the mucous membrane of which is smooth and glistening. The space enclosed by the false cords is oval in form and of such width that the true vocal cords can be readily seen from above. The latter are much stronger and thicker than the false cords, and approach more closely to the middle line of the larynx; between them is the rima glottidis, which is triangular in form. Judging from Mayer's figure of the larynx of *H. striata*, that of *H. crocuta* closely resembles it, differing, however, in the possession of well-marked false vocal cords, which, according to the author named, are absent in the former species. At the same time it is to be observed that Meckel[1] does not deny the presence of both false and true vocal cords in the larynx of *H. striata*. Taken as a whole, the larynx of *H. crocuta*, like that of *Proteles*, as pointed out by Prof. Flower, presents a greater resemblance to that organ in the Felidæ than in the Canidæ, differing from the former, however, in the oblique position and diminished prominence of the false vocal cords, and from both in the greater projection anteriorly of the thyroid cartilage, as well as in the presence of a sinus which separates the false cords from the base of the epiglottis and arytæno-epiglottidean folds of mucous membrane.

Thyroid gland.—Is very small and of an elongated-oval form. It lies under cover of the sterno-thyroid muscle, and extends on each side from the middle of the cricoid cartilage down to the sixth tracheal ring. The two halves are not connected by an isthmus.

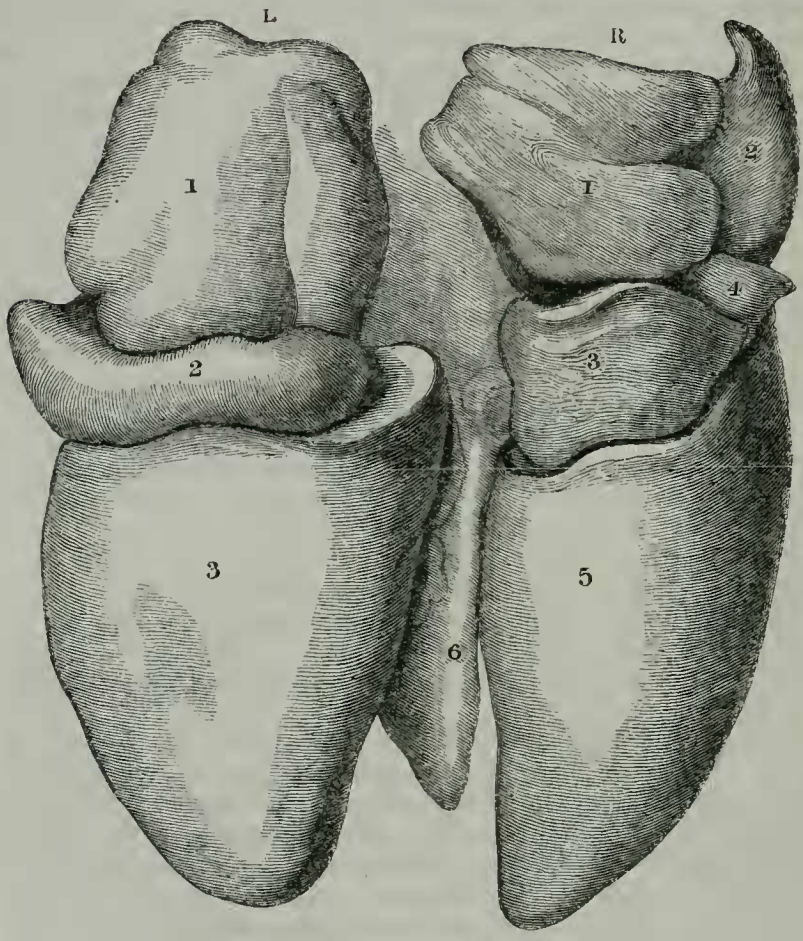
Trachea.—Is 11 inches in length. It possesses 49 cartilaginous rings (according to Meckel[2] 53); individual variation may account for this difference. The rings vary very much in breadth. In the trachea of *H. striata*, according to Meckel, there are 45, according to Reimann[3] and Wolff[4] there are but 36; in *Proteles* Mr. Flower counted 36.

Lungs.—The *right* lung is divided into 6 lobes, the left into 3. In the right lung there are two horizontal fissures, the lower of which indicates the separation between a basal lobe (which forms about one half of the lung) and the rest of the organ. The upper or apical half is divided into four lobes through the intersection of the upper horizontal by a vertical fissure. Of these, the lower and posterior lobe is almost square, and clearly separated from that above and below it, whilst the two anterior lobes are scarcely so well defined by reason of their coalescence towards the root of the organ. The sixth is the so-called azygos lobe, and lies between the upper and lower halves of the lung. The *left* lung is divided into an upper, a middle, and a lower lobe by means of two horizontal fissures, the inferior of which separates the lower from the upper half of the lung, whilst the upper divides the latter into two parts. Of these, the upper is the larger. On the outer surface of this lobe is a

[1] *Op. cit.* vol. x. p. 635.
[2] *Op. cit.* vol. x. p. 485.
[3] De Hyæna, Berol. 1811, p. 16.
[4] De org. vocis, Berol. 1812, p. 10.

vertical fissure, which indicates as it were, a tendency towards the more complete subdivision of the right lung. In respect of the number of pulmonic lobes *H. crocuta* differs from both the other species of *Hyæna*, in each of which the right lung possesses four and the left three. Dr. Murie mentions the presence of two marginal clefts in the upper lobe of the right lung of *H. brunnea*, which would

Fig. 4.



Lungs of *Hyæna crocuta*, distended and seen from behind.

R. Right lung; the figures 1, 2, 3, 4, 5, and 6 indicate the separate lobes, the latter figure being placed on the so-called azygos lobe. L. Left lung; the figures 1, 2, and 3 indicate its component lobes.

appear to indicate an approach to the arrangement described above in *Hyæna crocuta*. At the same time, the subdivision described by that author of the azygos lobe in the former does not obtain in the latter species. Meckel[1] states that in *H. crocuta* the lungs present

[1] *Op. cit.* vol. x. p. 492.

the same number of lobes as in *H. striata*; but this was not the case in our specimen. In *Proteles* the subdivision of the lungs resembles that in *H. striata*, but differs in the presence of two notches in the anterior border of the middle lobe on the left side. In respect, therefore, of the form of the lungs, *H. crocuta* differs more from either of the other species than they do from each other.

Vascular System.

Heart.—Is short and broad, as in the other species of *Hyæna*. Its cavities present the usual characteristics of the carnivorous heart. The fossa ovalis is clearly defined. There is no trace of a Eustachian valve. The aortic arch gives off two large trunks, of which that to the right is the innominate, which, as in the majority of Carnivora, divides into the right subclavian and right and left carotids. The second branch is the left subclavian. The trunk of the abdominal aorta gives off close to its termination the two external iliac arteries, and after a further course of 1 inch divides into the two internal iliac and caudal arteries. The origin of the external and internal iliac arteries as distinct branches of the abdominal aorta appears to be a somewhat unusual occurrence, so much so that it is mentioned by Prof. Huxley[1] as one of the characteristics of the *Didelphia*. Whether this arrangement occurs in other species of *Hyæna* is not mentioned by those authors who have examined them.

Urinary and Generative Organs.

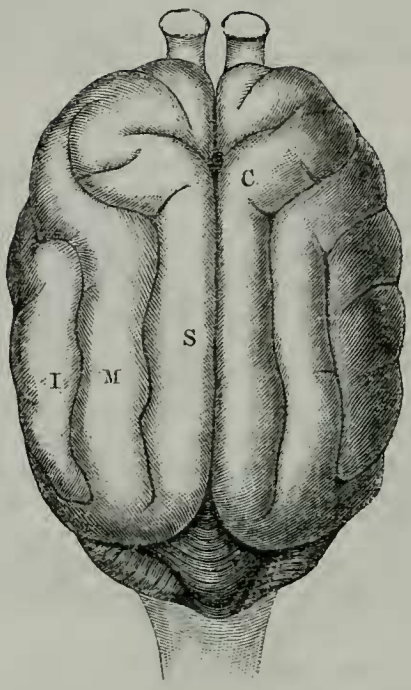
Kidneys.—Are situated very far back, the posterior extremity of each lying in the iliac fossa. The surface is smooth, and presents no trace of lobulation. They are globular in form, and much resemble the renal organ in the true Felidæ. As in them, a number of arborescent veins ramify upon the surface of the organ. On section, the kidney is seen to be composed of a single large pyramid, provided with a single papilla, and consequently differs in this respect from that of *H. brunnea*, in which, according to Dr. Murie[2], the cones are eight in number, at least in the cortical portion. In *H. striata*, Hunter[3] found a similar arrangement to that described in *H. crocuta*. The remaining portions of the urinary and sexual organs have been described before[4].

Brain.

The brain of *H. crocuta* so closely resembles in all respects that of *Proteles*, of which an excellent description has been given by Prof. Flower[5], that we have thought it unnecessary to enter into any lengthened description of this organ. At the same time, having regard to his observation that the brain of the Hyæna has not hitherto

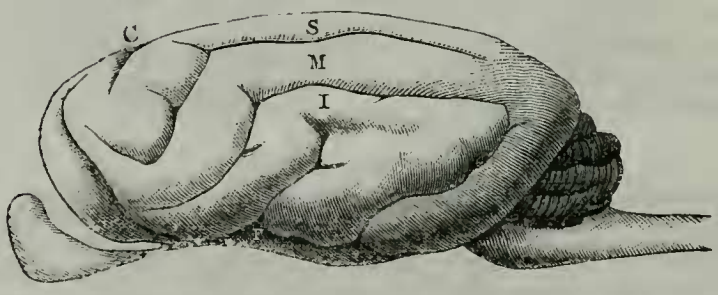
[1] 'Manual of Anatomy of Vertebrated Animals,' p. 327.
[2] Trans. Zool. Soc. vol. vii. p. 507.
[3] 'Essays and Observations,' by Owen, vol. ii.
[4] Proc. Zool. Soc. 1877. p. 369, and 1878, p. 417.
[5] Proc. Zool. Soc. 1869, p. 478.

Fig. 5.



Brain of *Hyæna crocuta*, two thirds natural size. Upper surface.
C, crucial sulcus; *S*, superior, *M*, middle, *I*, inferior external gyri.

Fig. 6.



Brain of *Hyæna crocuta*, lateral view.
F, sylvian fissure; other letters as in fig. 5.

been figured, and in view of the probable wants of subsequent investigators, we have thought it right to add the accompanying drawings. An examination of these, and comparison of them with Prof. Flower's figures of the brain of *Proteles*, will show that, except in respect of size, and the absence of a distinct fissure in that convolution which bounds the Sylvian fissure posteriorly, the description and comparative remarks of that anatomist apply equally to the brain of *H. crocuta* and to that of *Proteles*. The hemispheres of the brain measured each $3\frac{1}{4}$ inches in length; and the greatest breadth of the two together was $2\frac{5}{8}$ inches.

Myology[1].

To avoid the necessity of constant references in making comparisons of the muscles of the Spotted Hyæna, we wish it to be understood that, unless otherwise stated, the observations regarding *H. striata* and Cat have their source in Meckel's 'Anatomie Comparée,' those relating to the Dog in Douglas's 'Myographiæ Comparatæ,' whilst the notes respecting *H. brunnea* are derived from Dr. Murie's paper previously quoted, and those in connexion with the Civet from a paper by Macalister[2] and partly from our own dissections.

Muscles of the Head and Neck.

The *platysma myoides* consists of a strong broad sheet of muscular fibres, extending from the anterior half of the neck, covering the masseter and part of the mandible, and blending in front with the deeper muscles in the neighbourhood of the mouth.

Inasmuch as the region of the face was unfortunately somewhat damaged prior to our dissection, we are unable to give so accurate an account of its muscles as we would wish. They appeared however, to be strongly developed, and to consist of the following:—*orbicularis oris*, the external fibres of which take an attachment to the margin of the lateral nasal cartilage; *orbicularis palpebrarum*, which surrounds the eye, and has a bony attachment to the superior maxillary bone.

A *zygomaticus* runs from the temporal fascia in front of the ear to the angle of the mouth. There is also a strong *levator labii superioris et alæ nasi* and a smaller *levator anguli oris*. *Buccinator* is thin.

An *occipito-frontalis* is attached posteriorly to the temporal fascia in front of the ear, whilst anteriorly its fibres blend with those of the *orbicularis palpebrarum*.

Temporal.—This muscle, which possesses the ordinary attachments, is almost characteristic of the genus by reason of its great magnitude. In *H. brunnea* Murie speaks of it as enormous even for a Carnivore. As in *H. striata* and *H. brunnea*, so here the superficial fibres are with difficulty separable from the masseter.

[1] See Plates V. and VI

[2] "The Muscular Anatomy of the Civet and Tayra," Proc. Roy. Irish Acad. vol. i. ser. 2, p. 506.

The *masseter* is also very large; its attachments are as usual in Carnivores. Dr. Murie states that in *H. brunnea* "the masseter is clearly divisible into two layers, notwithstanding Meckel's assertion that this is less marked in the Hyæna than in the Cat." *H. crocuta* bears out the assertion of Meckel.

Of the two *pterygoid muscles* the internal is by far the largest. Arising from the external surface of the pterygoid bone, it is inserted into the ramus of the mandible, as also into its angular process.

The external pterygoid arises immediately above the internal, and passes to the neck of the lower jaw. Compared with the internal pterygoid, to which, by reason of an upward direction of its fibres, it is apparently antagonistic, this muscle is very small. Meckel notes a similar condition of the pterygoid in Carnivora generally.

The superficial muscles of the external ear are as follows:—*zygomatico-auricularis* from the zygoma to base of concha; *temporo-auricularis externus*, the origin of which is blended with the posterior belly of the occipito-frontalis just in front of the ear, inserted into the anterior margin of the conchal cartilage; *temporo-auricularis internus* from the temporal fascia immediately above zygoma to the inner side of concha.

Cervico-auricularis (superficial), narrow and riband-like from the ligamentum nuchæ to back of concha. Deep *cervico-auricularis* arises broad and fleshy from the temporal fascia close to the spine of occiput. It is inserted into the projecting part of conchal cartilage.

There are also well-marked *scuto-auriculares* (internal and external), and, in addition, certain intrinsic muscles, of which the best-marked are a vertical muscle of the concha running on the dorsum towards the tip, and two transverse muscles.

Sterno-mastoid arises in common with its fellow, to which it remains united for a little distance in front of the prosternum. It divides at once into two parts, of which the larger and internal decussates with the corresponding fibres of the opposite muscle as far forward as the larynx, and is finally inserted into the base of the mastoid process; whilst the smaller and more external part runs forward to end in the deep cervical fascia, and through it is attached to the occiput. This double character of the sterno-mastoid is remarked in *H. striata* and *H. brunnea* by Meckel and Murie respectively. It is also figured in the 'Recueil' (pl. 137) of Cuvier and Laurillard.

In Civet there is a cleido-mastoid entirely separate from the sterno-mastoid.

Digastric, as usual from the temporal bone, passes to the middle third of the inferior border of the lower jaw.

The *sterno-hyoid* and *sterno-thyroid* muscles arise close together from the thoracic surface of the sternum; quite separate they pass forwards, and have their usual insertions. A *thyro-hyoid* exists, and has the ordinary attachments; the *crico-thyroideus* is well marked. The *omo-hyoid* is absent, as in the Cat, Dog, Civet, and apparently in the majority of Carnivores. Meckel, however, affirms its existence as a small muscle in *H. striata*; it is not referred to by Murie in *H. brunnea*.

The *mylo-hyoid* extends from the inner surface of the mandible (where its attachment reaches from the anterior margin of the ramus to about two inches from the symphysis) to the hyoid bone posteriorly, and in front of this to a median raphe common to it and its fellow.

Genio-hyoid and *genio-hyoglossus* muscles, arising from the symphysis of the lower jaw, have their usual insertions. The *hyoglossus* is also normal in its connexions.

Styloglossus, usually strong in Carnivores, is in *H. crocuta* very large. It arises from the *cranial end* of the stylo-hyal bone, and passes to the side of the tongue. Wide in the Civet, it arises from the *middle* of the stylo-hyal.

The *stylo-pharyngeus*, also very strong, is from the stylo-hyal and tympano-hyal bones.

There is no *stylo-hyoid*. Meckel states that this muscle, which is ordinarily wanting in Carnivores, is present in *H. striata*, Cat, Dog, and Genet; Macalister found it in the Civet.

Scaleni.—Of these there are but two, both of which are situated behind (dorsad) the brachial plexus; consequently the *scalenus anticus* must be regarded as wanting.

The *scalenus medius* passes from the transverse processes of the fifth, sixth, and seventh cervical vertebræ to the first rib. *S. posticus* is from the fifth cervical vertebra to the fourth and fifth ribs.

The scalene muscles in *H. crocuta* are therefore similar in arrangement to those of *H. striata* and Dog, as described by Meckel. Douglas, however, avers the existence of three scalenes in the latter animal, thus agreeing with *H. brunnea*, in which, according to Murie, a *s. anticus* exists along with the *medius* and *posticus*; such is also the condition which obtains in the Civet.

The *rectus capitis anticus major*, from the transverse processes of the second to the sixth cervical vertebræ, to the basiocciput is but indistinctly separated from the *rectus capitis anticus minor*. The latter muscle springs from the arch of the atlas, and lies under cover of the major.

Longus colli occupies the cervical and anterior dorsal regions. Its fibres extend between the transverse processes and bodies of the various vertebræ over which it passes, with the exception of the axis, and terminate anteriorly at the arch of the atlas. These muscles do not differ materially in the Carnivora.

Splenius arises from the whole length of middle line of the neck, first two dorsal spines, articular processes of last five cervical and first dorsal vertebræ; it has its insertion solely into the outer half of the transverse ridge of the occiput. There is therefore no *splenius colli* present. This condition is usual in Carnivores. Douglas, however, notes a cervical attachment of *splenius* in the Dog.

Complexus.—This muscle forms an enormous fleshy mass in the region of the neck. It arises from the last five cervical articular processes and from the anterior two dorsal spines. Insertion is into occiput beneath splenius. There is no division into *complexus* and *digastric*, such as Meckel notes in *H. striata*.

Complexus tertius.—A series of strong fleshy bundles extends between the articular processes of the posterior cervical vertebræ; continued forwards as a separate muscular band, the fibres pass to the transverse process of the atlas, forming the muscle so-named. Murie describes a similar structure in *H. brunnea*, and regards it as corresponding to the *complexus tertius* in *Hyrax*.

The homological significance of this muscle appears, however, to have received varied interpretations by different anatomists, *e.g.* Mivart and Murie[1], recording their observations on the Myology of *Hyrax capensis*, write that "Meckel describes it as the *transversalis cervicis*; but this," they proceed to say, "it cannot be, as the *transversalis cervicis* is always the continuation into the neck of the *longissimus dorsi*, whereas our muscle lies distinctly internal to such continuation;" they further state that the true *transversalis cervicis* is the *cervicalis ascendens* of Meckel.

Whilst agreeing with the view of Mivart and Murie as to the nature of the muscle under consideration, and regarding it as a *complexus tertius*, we must take exception to their exposition of Meckel's views. We do not believe that Meckel described the muscle under any name, certainly in no case as forming solely the *transversalis cervicis*; neither does he confound the *cervicalis ascendens* with the *transversalis cervicis*.

The posterior *recti* and *obliqui* have their usual attachments. *Obliqus inferior* is comparatively very large. The *rectus capitis posticus major* consists of two parts, superficial and deep; such is also the case in the Dog, Bear, and Civet. *Rectus capitis lateralis* is inseparable from the superior oblique.

Spinalis colli extends from the first dorsal and last five cervical spines to the spine of the axis; there is no *semispinalis*.

The cervical *intertransversales*, arranged in pairs, are exceedingly large and strong.

Muscles of the Back, Thorax, and Abdomen.

The *panniculus carnosus* in *H. crocuta*, as in Carnivores generally, forms an extensive muscular sheet, specially strong on the lateral aspects of the trunk, and extending more or less over the dorsal and ventral regions. It arises from the fascia over the *latissimus dorsi*, and posteriorly from that covering the thigh. There is, however, no femoral attachment. The fibres converge towards the axilla and join the *latissimus* about four inches above its humeral attachment.

Trapezius is small. It arises from the spines of the seven anterior dorsal vertebræ and from the ligamentum nuchæ opposite the last two cervical spines. Its insertion is into the whole length of the scapula. This represents the posterior part of the trapezius of Meckel in *H. striata*, his anterior portion being our *levator humeri*.

The *latissimus dorsi* takes origin from the posterior eleven dorsal spines and from the lumbar aponeurosis; it has no costal attachment. Joined by the panniculus, it is inserted along with the teres

[1] "On the Myology of *Hyrax capensis*," P. Z. S. 1865, p. 333.

major into the shaft of humerus at the junction of its upper and middle thirds. It agrees closely with Meckel's description of this muscle in *H. striata*, and also with what exists in *H. brunnea* and Civet. As in them, it also gives off a *dorsi epitrochlearis*.

The *rhomboideus* is a single muscle. It arises from the ligamentum nuchæ corresponding to the last two cervical vertebræ, and also from the anterior four dorsal spines. Insertion is into the superior costa, as well as about an inch of the anterior costa, of the scapula.

It has no occipital attachment such as Meckel found in *H. striata*, in this respect agreeing with *Viverra* and, according to Douglas, with the Dog.

Superior and inferior *serrati postici* are not combined as in *H. brunnea*; though *almost* continuous, they are distinguishable by the different direction of their fibres. The *superior* is from the seven anterior dorsal spines, its costal attachment extending from the fourth to the eleventh ribs. *Inferior serratus* is from the lumbar aponcurosis to the four posterior ribs.

Erector spinæ is subdivided as usual. The *sacro-lumbalis* small, is inserted into the last four ribs; it is prolonged forwards, however, to the first rib by a *musculus accessorius*. There is no cervical continuation in the form of a *cervicalis ascendens*.

The *longissimus dorsi*, smaller than the *spinalis dorsi*, is attached by fleshy bundles to the ten anterior dorsal transverse processes, and by tendinous slips to the corresponding ribs. An enormous *transversalis cervicis* is continued into the neck. It arises from the posterior four cervical and anterior four dorsal articular processes, receiving in addition accessory bundles from the third, fourth, fifth, and sixth dorsal spines; it is inserted into the transverse processes of the last five cervical vertebræ. The *trachelo-mastoid* is absent.

Spinalis dorsi, the innermost and largest subdivision of the *erector*, is inserted into the spines of the anterior dorsal and last two cervical vertebræ.

Apparently these muscles are similarly arranged in *H. striata* and *H. brunnea*. In these animals the unusual nature of the relative sizes of the dorsal muscles, the one to the other, is noted by Meckel and Murie respectively. As Dr. Murie puts it, "the *serrati postici* usually small, are here large; the *sacro-lumbalis* and *longissimus dorsi*, on the contrary, are comparatively small, although in themselves of no mean bulk; but the *spinalis dorsi* obtains by far the largest dimensions, and is indeed a very powerful muscle of enormous magnitude." In the main these remarks are equally applicable to *H. crocuta*.

In the Civet Macalister records a *cervicalis ascendens* and also a *trachelo-mastoid*.

The *multifidus spinæ* extends as far back as the seventh caudal vertebra. *Rotatores spinæ* are large; the *interspinales* are also well marked.

Levatores costarum, with the usual attachments, are very strong; their fibres are quite continuous with those of the external intercostal muscles.

Serratus magnus arises from the transverse processes of the five posterior cervical and first dorsal vertebræ, and by seven costal slips from the eight anterior ribs, excluding the first. It is inserted into the vertebral border and part of the ventral surface of the scapula. The muscle is similarly arranged in *H. striata*. In the Civet the cervical part is limited to four vertebræ; and in the Dog the costal attachment is less by one digitation.

The *intercostal* series of muscles are normal.

Triangularis sterni strong and well marked. It takes origin from all the pieces of the sternum except the first, and passes to the cartilages of the second to the sixth ribs inclusive. A separate muscular band arises from the side of the eighth sternal segment, and runs transversely to the posterior margin of the seventh costal cartilage; though distinct from the triangularis and interposed between it and the intercostal muscles, it can only be regarded as an aberrant slip of that muscle.

The *diaphragm* has the ordinary attachments. It possesses no special aperture for the passage of the vena cava, that vessel passing with the aorta *behind* the crura.

Of the abdominal muscles the *external oblique* is from the last eleven ribs to its usual insertion. The *internal oblique* is easily separable from the *transversalis*.

Rectus abdominis, from the posterior extremity of the symphysis pubes, is inserted into the seven anterior costal cartilages, close to the sternum. The prolongation of the rectus to the first rib is usual in Carnivores. As in *H. brunnea*, there is no *pyramidalis*; this muscle is also absent in *H. striata*. There is but a single *supracostalis*; it extends from the cartilage of first rib to the aponeurotic insertion of the rectus opposite the third and fourth costal cartilages. Two such muscles are noted in *H. brunnea*, whilst the Dog agrees with *H. crocuta* in possessing only one ("musculus in summo thorace situs" of Douglas).

Coccygeus is attached to the roots of the transverse processes of the first three coccygeal vertebræ and to the ischial spine.

The remaining muscles of the region, *i. e.* those in relation to the generative organs and rectum, are described in a previous communication.

The tail is supplied with a *levator caudæ*, which arises from articular processes of the last three lumbar vertebræ, and is reinforced by muscular slips from the laminæ of the caudal vertebræ, into the spines of which it is inserted by means of delicate tendons.

The *depressor caudæ*, from the bodies of sacral and coccygeal vertebræ, receives also a special muscular slip from the pelvic aspect of the ilium. Its insertion is by narrow tendons into the bodies of the caudal vertebræ.

Laterales caudæ are constituted by the intertransversales of the caudal region.

Muscles of the Fore Limbs.

Pectoralis major, from the whole length of the sternum, and ex-

tending forwards for about one inch from a mesial raphe in the neck, this muscle is inserted into the whole length of the shaft of the humerus, from the bicipital groove down to the elbow. The fibres are easily separable into a superficial and a deep stratum, thus corresponding closely to the arrangement in *H. striata*.

In the Civet the pectoralis major, as in the Dog, consists of three strata, whilst its insertion is much more limited than in *H. crocuta*.

Pectoralis minor wanting, as in Carnivores generally[1].

Deltoid consists of two parts—one, narrow, from the tip of acromion, and a second, wider, from the fascia covering the infraspinatus; they are inserted together into the deltoid ridge of the humerus. The so-called clavicular portion of the deltoid we describe with the *levator humeri*; but including this element, the deltoid of *H. crocuta* is evidently the same as Meckel describes in *H. striata*, and agrees with what we find in *Viverra*. Douglas describes the deltoid in the Dog as we do in *H. crocuta*, the acromial and scapular portions, however, not being so easily separable.

Levator humeri proprius (Douglas) arises by two heads—one, thin, from the anterior half of the neck, dorsal mesial line, and a second, riband-like in character, from the mastoid process. The heads unite in front of the shoulder-joint; and the resulting belly is inserted into the lower end of the shaft of the humerus, in front of the biceps.

This corresponds to the *cephalo-humeral* described by Murie in *H. brunnea*, whilst by Meckel it is in *H. striata* regarded as a portion of the double trapezius.

The *subscapularis*, from the venter scapulæ (except so much as affords attachment to the serratus magnus) to the smaller humeral tuberosity. *Infraspinatus* and *supraspinatus* are both strong and well developed; they, as well as the *subscapularis*, present no deviation from the usual arrangement.

Teres minor is small, but is distinct from the *infraspinatus*, as in Civet and Dog.

A *levator scapulæ* (trachelo-acromial) arises from the inferior border of the transverse process of the atlas, and runs to the acromial process of the scapula. The same arrangement is mentioned by Meckel in *H. striata* and *Viverra*, and by Douglas in the Dog.

Teres major is from the upper half of the posterior margin of the scapula. Its insertion unites with that of *latissimus dorsi*, as in Civet.

The *biceps* is single-headed, attached above to the upper border of the glenoid cavity, and below to the inner borders of both radius and ulna. In respect of origin it agrees with *H. striata* and Dog. In the Civet the biceps is coracoid in origin, and entirely radial at its insertion.

Brachialis anticus, from almost the whole length of the posterior surface of the shaft of humerus, winds round the outer side of the lower half of that bone, and is inserted into the upper two inches of the internal border of the ulna. The arrangement is essentially the same in the Civet and Dog.

[1] Cuvier, Leçons d'Anat. Comp. vol. i. p. 256.

The *coraco-brachialis* is a *c. brevis* (Wood). It springs from the upper border of glenoid cavity, and passes to the shaft of the humerus just above the insertion of the latissimus. Such, according to Wood[1], is also the arrangement in the Dog and Cat; and so have we found it in the Civet. In other of the Carnivora, *e. g.* Bears, the coraco-brachialis exists as a double muscle, corresponding to the long and short varieties of Wood.

The *triceps* possesses four distinct heads. Of these the scapular, very large, springs from nearly the whole length of the axillary costa of scapula. The second and third arise from the upper third of the humeral shaft, and are separated by the origin of *brachialis anticus*. The fourth head is a small muscular bundle from the olecranon-fossa and adjoining part of the shaft of humerus. These heads have a common insertion into the olecranon process of ulna.

In the Civet the muscle is similarly constituted; the long head, however, is more limited at its scapular attachment.

Supinator longus is absent; a tendinous vestige exists and apparently represents it. According to Meckel it is also wanting in *H. striata*; whilst Douglas records its absence in the Dog. In the Civet, however, it exists, comparatively small and feeble, but quite distinct.

The *extensores carpi radiales longior et brevior* arise conjointly from the outer condyloid ridge of humerus. Fused for some distance the two muscles are inseparable; the respective fibres, however, terminate on two separate tendons, which are inserted into the metacarpals of index and middle digits. The muscular fibres at the origin are similarly interblended in the Civet and Dog, whilst in *H. striata* Meckel describes the muscles as distinct throughout, the tendons being united by a transverse band.

Extensor communis digitorum, from the outer condyle and intermuscular fascia, terminates in the usual manner, passing to the four outer toes.

There is an *extensor carpi ulnaris*, from the external condyle to the base of metacarpal of little digit.

A small *supinator brevis* passes from the orbicular and external lateral ligaments to the radius anteriorly, reaching just below the elbow.

A double *extensor minimi digiti* springs from the outer humeral condyle; its tendons pass to the two outermost digits (*annularis* and *minimus*). The same obtains in *H. striata*. In the Civet the muscle terminates by three tendons, which are distributed to the three outer toes; whilst, according to Douglas, in the Dog there is but a single tendon of insertion, this being confined to the fourth digit (*annularis*).

The *extensor primi internodii* is wanting or is quite inseparable from the *extensor ossis metacarpi pollicis*. The latter arises from the whole length of internal surface of ulna and adjoining interosseous membrane, and also slightly from the upper end of the radius. It is inserted into the base of rudimentary pollex. Such also is the arrangement in the Dog, Civet, and *H. striata*.

An *extensor indicis* passes from the middle of the external border

[1] Wood, "on Muscular Variations," Journal Anat. and Phys. vol. i. p. 55.

of ulna to the index finger, there joining the common extensor tendon in the usual manner. Meckel notes an extensor indicis in *H. striata*, but says it is distributed to the third finger.

In the Civet a conjoined *extensor secundi et indicis* is found.

The *pronator radii teres*, from internal condyle of humerus to junction of upper and middle thirds of radius, is slender; it does not differ from that of *H. striata*. In the Civet, on the contrary, the muscle is particularly strong, and extends down to the lower end of the radius.

In *H. crocuta*, the smallness and comparative feebleness of the round pronator is compensated by an extensive *pronator quadratus*, which is attached to the whole length of the bones of forearm. Large also in *H. striata*, Dog, and Cat, it is limited in Civet to the lower third of the forearm.

The *flexor carpi radialis* arises from the inner condyle, and is inserted into the base of the second metacarpal bone. In the Civet there is an additional inferior attachment to the base of the first metacarpal.

Palmaris longus is quite distinct from the inner condyle, and terminates in a strong palmar fascia. Meckel states that in *H. striata* this muscle is intimately blended with the superficial flexor of the digits. According to Douglas, it is entirely wanting in the Dog. In the Civet, on the other hand, somewhat remarkably, it forms a double muscle from end to end.

Flexor carpi ulnaris, from the internal condyle of humerus to the pisiform bone, is prolonged also to the outermost metacarpal. So also in *H. striata* and Civet; in the latter animal an olecranoid origin likewise exists.

Flexores digitorum.—The superficial and the deep form one large irregular muscular mass. This arises from the internal humeral condyle, and also from the bones of forearm—one slip taking origin from the upper extremities of both radius and ulna, while a second comes from the whole length of the posterior border of ulna. Below the middle of the forearm the muscle divides into two parts, a superficial and a deep.

The superficial (*perforatus*) is distributed by means of separate tendons to the four outer toes, each tendon ending at the middle phalanx of its respective digit, and giving passage to the corresponding deep flexor tendon in the usual manner.

The deeper part of the muscle (*perforans*) ends in a single broad tendon which divides into four, and so is distributed to the same four toes as the superficial tendons, perforating these latter, and reaching the terminal phalanges of the digits. This complication of the flexors of the digits appears to be common in the Carnivora. A particularly interesting modification, however, exists in the Civet, in which animal the distribution of the perforatus (*i. e.* the superficial part of the common flexor mass as in *H. crocuta*) is limited to the three middle digits, no tendon passing to the outermost. The latter, however, possesses a special little muscle[1] which arises from the

[1] Mivart and Murie describe a similar muscle in *Hyrax capensis* (P. Z. S. 1865, p. 341), and designate it "flexor brevis manus."

pisiform bone and from the annular ligament ; the fibres terminate on a tendon which, after being pierced by the deep flexor tendon of the fifth digit, is inserted into the second phalanx of that digit, and consequently represents its superficial flexor tendon. A similar but smaller muscular slip runs to the fourth toe, and joins the superficial flexor tendon.

Somewhat analogous is the condition elaborately described by Meckel in *H. striata*—the palmar accessory slips, however, not being confined to the two outer digits as in the Civet, but running to all four, each tendon of the superficial flexor thus receiving an additional slip. In *H. striata*, it is to be noted, the accessory slips are altogether tendinous, apparently springing simply as offsets from the expansion of palmaris longus. They do not possess the muscular portions so well marked in the case of the Civet.

There is no representative in *H. crocuta* of the *flexor longus pollicis* described by Meckel as existing in *H. striata*.

Lumbricales are four in number. All arise from the palmar surface of the common deep flexor tendon, and pass to be attached to the deeper aspect of the superficial flexor tendons. The nature of this peculiar attachment of the lumbricals is apparently the same in *H. striata*, and is to be found figured in Cuvier and Laurillard's 'Recueil,' pl. 141. fig. 3.

In the hand, the pollex, as in *H. striata*, is deprived of any special muscles ; the little finger is furnished with an *abductor minimi digiti* ; this, from the pisiform bone, joins the extensor-expansion on dorsal aspect of first phalanx of fifth digit. This muscle also exists in the Civet. According to Douglas it is wanting in the Dog. In this latter animal Douglas avers the presence of a small flexor and an opponens of the pollex.

The *interossei* muscles are strong and well developed, their arrangement being very similar in Carnivora generally. In *H. crocuta* a deep set comprises eight fleshy bundles arranged in pairs, two to each metacarpal, situated rather on the palmar aspect of these ; they arise from their proximal ends, and pass to the sides of the bases of the first phalanges, reaching as far as the extensor-tendon.

In addition to these paired muscles are two single ones (palmar interossei). These arise together from the bases of the third and fourth metacarpals. They are distributed to the middle and outermost digits respectively.

Muscles of the Hind Limbs.

In Carnivores generally the *gluteus maximus* (*externus*) is more or less divisible into two parts—this, as observed by Meckel, being especially well marked in *H. striata*.

In *H. crocuta* a similar disposition holds good—the anterior part of the muscle, thin and flat, springing from the spines of the posterior sacral vertebræ, and passing to the fascia lata, whilst the posterior moiety, forming a perfectly distinct elongated and fusiform bundle, springs from the transverse processes of the three anterior caudal

vertebræ and terminates by a tendon which, blending with the fascia lata immediately above the knee-joint, is continuous with the *biceps flexor cruris*.

The *gluteus medius*, as usual, exceeds in bulk the so-called maximus. It arises from the external surface of the iliac bone and from the fascia covering the muscle, and is inserted into the outer surface of the great trochanter of the femur.

Perfectly distinct, the *gluteus minimus* arises behind the last-mentioned muscle from the gluteal surface of the ilium and from the dorsum acetabuli. Its insertion is into the antero-external border of the great trochanter. The muscle is partially divisible into two, the posterior fibres passing to their insertion on a deeper plane than the anterior.

A fourth gluteus (*gluteus quartus*) arises from the anterior border of the acetabulum over the reflected tendon of the rectus femoris, and is inserted into the middle of the anterior intertrochanteric line. This muscle appears to have been first described by Douglas in the Dog, under the name of "musculus parvus in articulatione femoris situs." Its existence in *H. striata* is noted by Meckel, and in the Civet by Macalister ("gluteus quintus") and ourselves.

The *pyriformis* has origin from the middle third of the ventral surface of the sacrum, and, running quite distinct and separate, is inserted into the great trochanter. Meckel found it in *H. striata*, but notes its absence in the Bear. It exists as a distinct muscle in the Civet.

Obturator internus, which arises as usual, after emerging from the pelvic cavity, is accompanied to its termination by two well-marked and strong *gemelli*. The common insertion is into the trochanteric fossa.

The *obturator externus* arises from the obturator-membrane and its bony boundary. It is also inserted into the trochanteric fossa of the femur.

Quadratus femoris is from the outer border of the ischial tuberosity to the posterior border of the great trochanter.

The above five muscles are similarly arranged in the Carnivora generally.

Of the hamstring-muscles the *semimembranosus* is quite inseparable from the *adductor magnus*, in the description of which it is therefore included. To a more or less marked degree this union of the muscles is, according to Meckel, usual in Carnivores. He states, however, that in the Hyæna, Bear, Raccoon, and Coati the semimembranosus exists as a distinct muscle. We have also found it quite separate throughout in *Viverra*, though in this animal Macalister states the contrary to be the case. This latter observer further notes its separate character in the Tayra.

The *semitendinosus* arises from the ischial tuberosity, and is inserted into the internal surface of the shaft of the tibia near its superior extremity. Meckel found the insertion of this muscle to be lower in *H. striata* than is the case in *H. crocuta*; whilst in the Cynoids and Arctoids it is still lower down than in the Hyæna.

In the absence of a caudal origin the semitendinosus in *H. crocuta* differs from that of *Viverra*.

The *biceps*, strong and bulky, springs from the tuberosity of the ischium. The anterior two thirds of its fibres terminate on the ligamentous structure on the outer side of the knee, whilst the remaining third ends on a tendinous band which reaches down to the os calcis.

In the Civet the arrangement is very similar.

Tensor fasciæ femoris, from the anterior half of the lower border of the ilium, is inserted into the fascia lata about the middle of the outer side of the thigh. Douglas describes this muscle in the Dog as being double-headed.

The *sartorius* takes origin from the anterior spine of the ilium; and whilst one set of fibres pass obliquely to the upper end of the tibia as usual, a second set run straight down superficial to the rectus femoris, and joins this latter low down, forming an additional element in the common extensor.

The two parts so described are united simply by membrane, they themselves forming distiuct muscular bundles. The muscle may be regarded, therefore, as a double sartorius, or the outer fibres as forming a *superficial rectus* or fifth extensor, such as was first described by Douglas in the Dog under the name of "extensor tibiæ primus cani proprius." In many Carnivorous animals the two bundles are united and continuous, a single muscle therefore resulting, viz. the sartorius. In the Civet such is the case, though Macalister in his specimen found it double.

The *gracilis* has a broad aponeurotic origin from the posterior part of the symphysis pubis, and also from the anterior portion of the pubic arch. It is inserted into the internal surface of the shaft of the tibia at its upper part. Exactly the same arrangement is found in the Civet and also in *H. striata*.

The *pectineus* is from the ilio-pectineal line to the middle of the linea aspera of the femur.

In the Civet this muscle is large and double at its insertion, which, however, does not extend below the middle of the shaft of femur. In the Dog, whilst the pectineus is single, according to Meckel its insertion reaches down to the internal condyle.

Adductor magnus arises from the pubic arch, for two inches in front of the ischial tuberosity. The fibres form a comparatively long and narrow muscle, which, bifurcating low down, is inserted partly into the line leading to the internal condyle of the femur, and also by a distinct but narrow tendon into the internal tuberosity of the tibia. This latter probably represents the insertion of the semimembranosus, which in *H. crocuta* must be regarded as coalesced with the great adductor. In this respect, as stated before, *H. crocuta* conforms to the Carnivorous type, but differs from *H. striata*, Bear, Raccoon, Coati, Civet, and Tayra.

Adductor brevis, of considerable magnitude, forms the remaining and greater part of the adductor mass. It takes origin from the body of the pubis and from the anterior half of the pubic arch, and

is inserted into the whole length of the linea aspera, as well as into the internal of its lower bifurcations.

Rectus femoris is tolerably well developed. It originates partly from the anterior (inferior) spinous process of the ilium, and also by a well-marked reflected tendon from the dorsum acetabuli. In the Civet the two heads exist as usual, whilst in *H. striata* Meckel found that the two heads of origin were not distinct. The muscle terminates in the usual manner.

The *vasti* muscles, as in *H. striata*, are hardly separable. They form a large muscular mass which arises from the upper half of the shaft of the femur, and, with the rectus femoris and the straight fibres of the sartorius, are inserted into the anterior tubercle of the tibia.

Crureus is absent or is not to be differentiated from the vasti.

In the Civet there is a much more strongly marked distinction between these deeper heads of the quadriceps extensor.

Gastrocnemius, well developed, arises by two heads as usual; its insertion below is into the os calcis.

The *soleus* is wanting. In this respect *H. crocuta* agrees with *H. striata* and with the Dog and Cat[1], but contrasts strongly with the Civet, in which the soleus exists as a separate muscle throughout. It is also present in the Bear.

Plantaris.—This arises along with, but internal to the external head of origin of the gastrocnemius. Its tendon joins that of the latter muscle low down, close to the os calcis, and is inserted with it. The plantaris-tendon is not continued into the sole, either as the plantar fascia or as the flexor brevis digitorum. In the Civet the plantaris is comparatively large, and its tendon does not end at the os calcis, but, expanding somewhat, runs over the tuberosity of that bone to become continuous with the flexor brevis digitorum. Meckel notes a similar prolongation of the muscle into the foot in *H. striata*.

Popliteus is from the external femoral condyle. Its insertion is into the posterior surface of the tibia above the oblique line, and further, extending halfway down the shaft. It is similarly arranged in *H. striata* and the Civet.

The *tibialis posticus*, as usual in Carnivores, is small but normal. Very thin and slender in *H. crocuta*, it arises below the popliteus from the middle third of the postero-internal border of the tibia. Its tendon is inserted into the scaphoid and entocuneiform bones.

The long flexor of the toes (*perforans*), representing the conjoined *flexor longus hallucis* and *flexor longus digitorum* of human anatomy, arises by two heads, of which the internal (*flexor longus digitorum*) is small and springs from the head of the fibula and intermuscular septa separating it from neighbouring muscles. The external head (*flexor longus hallucis*) is much larger; it arises from the superior extremity and upper half of the shaft of fibula, from a corresponding extent of tibia, and from the interosseous membrane. Each of these heads terminates on a distinct tendon, which, passing through a separate sheath in the annular ligament, unite in the sole of the foot

[1] Chauveau's 'Comparative Anatomy,' translated by Fleming, p. 309.

to form a single broad tendon from which four slips are derived; these, after perforating the superficial flexor-tendons, are inserted into the terminal phalanges of the toes.

This fusion or junction of the tendons of the flexors hallucis and digitorum exists in *H. striata*, the Dog, and Cat, and also in the Civet.

The *flexor brevis digitorum* (*perforatus*) in *H. crocuta* is confined to the sole of the foot, and is represented solely by tendon, a muscular belly being entirely wanting. This tendinous structure is attached posteriorly to the os calcis, and anteriorly divides into four slips, which, splitting for the passage of the corresponding deep flexor tendons, terminate on the sides of the second phalanges of their respective toes. Quite different is the arrangement in *H. striata*, in which the flexor brevis digitorum is described by Meckel as a prolongation of the tendon of the plantaris, receiving additional muscular fibres in the sole from the fourth metatarsal bone. The Civet presents a similar disposition, the additional muscular fibres being, however, derived from the os calcis. In the Cat a distinct muscular belly exists, springing from the tendon of the plantaris[1].

Musculus accessorius.—This muscle exists in *H. crocuta*, exceedingly small and slender. About one inch in length, it stretches from the front of the os calcis to join the tendon of the long flexor on its outer side. Meckel does not note its presence in *H. striata*, whilst Douglas avers its absence in the Dog. Chauveau, however, speaks of its existence as a small undeveloped muscle in both the Dog and Cat[2]. It exists well marked in *Viverra*.

Lumbricales are three in number, as in the fore foot. They all spring from the tendons of the long flexor, and join those of the short. Their arrangement is as follows.—The first lumbrical arises from the superficial aspect of the deep tendon before its subdivision, and passes to the slip of the flexor brevis which is distributed to the third toe; the second arises below the first, but joins the same tendon of the flexor brevis; whilst the third arises from the point of bifurcation of the deep tendons going to the two outer toes, and is inserted into the tendon of the flexor brevis to the fourth toe.

(*Note*.—In speaking numerically of the respective toes, we include the rudimentary hallux.)

The *interossei* of the hind foot constitute a set of small muscular bundles, two to each toe, excluding the hallux. They all spring from the plantar aspect of the proximal extremities of the metatarsal bones, and pass upon either side of these bones to their distal ends, where they are inserted partly into the sesamoid bones and also into the extensor-tendons of the same toe; as pointed out by Meckel, they exercise principally the function of flexors.

Extensor longus digitorum is, as usual, in Carnivores femoral in origin, springing from the outer surface of the external condyle. Its tendon passes, along with that of the tibialis anticus, beneath the annular ligament, and gives off three slips, which are distributed to the second, third, and fourth toes, none passing to the little or outer

[1] Meckel, *loc. cit.* p. 451. [2] *Loc. cit.* p. 311.

toe; in this respect it differs from those in the Civet and Dog. According to Meckel, in *H. striata* this muscle divides into two distinct bellies, and gives off five tendons. In the Civet the muscle is undivided.

An *extensor hallucis* does not exist as a separate muscle, a slip from the tibialis anticus being its only representative.

Tibialis anticus arises from the external surface of the upper third of the tibia; halfway down the leg the muscle divides into two, each division terminating on a separate tendon; of these the one (*tibialis anticus*) is inserted into the entocuneiform bone, whilst the other (*extensor hallucis*) goes to the metatarsal of rudimentary great toe.

There is no separate *extensor hallucis proprius*, such as exists in the Civet or Dog.

Extensor brevis digitorum, from the os calcis, terminates by three tendons, which pass to the second, third, and fourth toes. The same obtains in *H. striata*. In the Civet the muscle is distributed to the four inner toes, whilst in the Dog it is to the four outer.

Peronæi are two in number. Of these the *longus* arises as in *H. striata*, Bear, Coati, &c., from the external condyle of the femur; it has also an additional origin from the external tibial tuberosity. Insertion is solely into base of fifth metatarsal bone, as in *H. striata*. In the Civet it is fibular in origin, and its tendon of insertion, after giving a slip to the fifth metatarsal, is continued to the first.

The *peronæus brevis* arises below the longus from the middle two thirds of shaft of fibula, and terminates in two tendons, one of which passes on the dorsal aspect of the outer toe and joins the expansion of extensor-tendon, whilst the second is inserted into the base of the metatarsal bone of the same toe.

In *H. striata* the first tendon joins the extensor of the fourth toe. In the Dog the insertion is as in *H. crocuta*. In the Civet, and in the Bear also, a third peronæus exists ("peronæus quinti," Macalister) which, as observed by Meckel, may represent the peronæus tertius. It joins the extensor-tendon of the fifth toe over the first phalanx.

The tendency towards the formation of a third peronæus is well evidenced by the double insertion of the peronæus brevis in the Dog, and the still better marked division inferiorly in *H. crocuta*. Comparing these with the Civet or Bear, a progressive and more complete differentiation obtains, up to the formation of entirely separate muscles.

Concluding Remarks.

Having now described at some length the anatomy of *H. crocuta*, it may be well to add a few words by way of comparison of the structure of this with that of the other species which most closely resemble it. The arrangement of the muscular system of *H. crocuta*, so far as one can judge from an inspection of the plates of Cuvier and Laurillard, and from a perusal of the somewhat fragmentary notes which have been published with reference to other species, appears to be very similar to that of *H. striata* and *H. brunnea*, and

to differ in several important particulars from that of the Viverridæ, as well of the true Felidæ. The enormous development of the muscles of the neck and fore quarters, together with minor points already referred to, serve at once to associate *H. crocuta* with the other species of the same genus, and to separate it from the remaining groups of the Æluroidea. Unfortunately, so far as we can ascertain, the myology of *Proteles* has not yet been worked out; but if we may base any conclusion regarding its muscular system upon the external configuration of the animal, that system will not differ materially from what we find in *Hyæna*.

A good description of the brain of other species of *Hyæna* is still a desideratum. With the exception of Prof. Flower's observation that the brain of *Proteles* resembles that of a Hyæna (species unknown) in the Museum of the Royal College of Surgeons, we possess no reliable information regarding the arrangement of the cerebral convolutions in the latter genus. So far as the information derived from a comparison of the brain of *H. crocuta* with that of *Proteles* goes, it shows that these two species are closely allied to one another, and that, as pointed out by Prof. Flower in *Proteles*, so also in *H. crocuta*, the brain occupies an intermediate position between that of the true Cats, in which the convolutions are slightly more complex, and that of the Viverrids, in which they are slightly less so. The vascular system of the Spotted Hyæna does not present any remarkable deviation from that of the Carnivora in general, except the mode of origin of the iliac arteries. In respect of the relative lengths of the small and large intestines, this species seems to deviate from the true Cats, in which, according to Meckel, these stand in the relation of 5 to 1, and to approach the Viverrids, in which the small is to the large intestine as 12 or 15 to 1, more than do the other species of the genus. The measurement of the comparative lengths of the small and large intestines, correlatives as these are of well-defined physiological processes, appears to us to be more important in determining the affinities of closely allied species than that of the relative length of the intestine and body of the animal, the latter varying much in accordance with the habits and mode of life, whilst the food may remain the same.

The hyænoid form of larynx is well marked in *H. crocuta*, and serves to distinguish it, together with its congeners, from the other groups of the Carnivora. So far the structure of *H. crocuta* agrees closely with what we find in other species of the genus. But when we come to the consideration of the reproductive organs we meet with an element of classification which, diverging as these organs do so strikingly from the Carnivorous and even Mammalian type, would, taken *per se*, justify us in establishing a separate genus for the reception of *H. crocuta*. The unnecessary multiplication of genera appears to us, however, to be open to objection, as tending to defeat the chief object of classification; and therefore, in view of the close resemblance which otherwise exists between *H. crocuta* and other species of the genus, we think it advisable to retain for it the old generic title. And while we thus express ourselves, it may not be out

of place to remark that the occurrence of this divergence from the usual type, so far as its female organs are concerned, in an animal which in all other respects so closely resembles its fellows, may well serve to demonstrate the uncertainty of any scientific classification founded on any thing short of the consideration of the *entire* structure of any animal. Had the comparative anatomist examined only the female organs of *H. crocuta*, there can be little doubt that he would have established a separate genus, if not a family, for the reception of the animal to which they belonged. The necessity for such a course, however, is, as already pointed out, obviated by the more complete examination of the structural details of the animal.

Lastly, it might be of interest to speculate as to how in the course of evolution of three species so closely allied as the three species of *Hyæna*, two of these should have conformed to the normal mammalian type in every particular, whilst the third diverged so remarkably from that type in respect of the structural configuration of a single group of organs. Such speculations, however, do not come within the scope of a paper devoted exclusively to a record of facts.

EXPLANATION OF PLATES V. & VI.

Plate V. Right side of *Hyæna crocuta*, to show the superficial layer of muscles; drawn from the recent dissection:—*G.mx.*, gluteus maximus, its two parts; *G.md.*, gluteus medius; *B.f.*, biceps femoris; *T.v.f.*, tensor vaginæ femoris; *Sa.*, sartorius, "its vertical fibres forming a superficial rectus;" *P.c.*, panniculus carnosus; *Tr.*, trapezius; *P.*, platysma; *L.d.*, latissimus dorsi; *P.m.*, pectoralis major; *T.*, triceps; *L.h.*, levator humeri; *L.s.*, levator scapulæ; *D.*, deltoid.

Plate VI. Deeper muscles, on right side of *H. crocuta*: *G.mx.*, gluteus maximus reflected; *G.mn.*[1], gluteus minimus, its two portions; *G.mn.*[2], insertion of the anterior fibres of gluteus minimus; *B.f.*, biceps femoris, reflected; *G.q.*, gluteus quartus; *Sa.*, sartorius; *R.f.*, rectus femoris; *O.i.*, obturator internus and gemelli; *Q.f.*, quadratus femoris; *A.b.*, adductor brevis; *A.m.*+*s.m.*, adductor magnus+semimembranosus; *V.e.*, vastus externus, "hooked back;" *P.*, plantaris; *Ga.*, gastrocnemius; *F.l.d.*, flexor longus digitorum; *P.l.*, peronæus longus; *P.b.*, peronæus brevis; *E.l.d.*, extensor longus digitorum; *T.a.*+*E.l.h.*, tibialis anticus+extensor longus hallucis; *E.o.*, external oblique; *R.a.*, rectus abdominis; *P.c.*, panniculus carnosus, cut; *L.d.*, latissimus dorsi; *D.e.*, dorsi epitrochlearis; *T.*, triceps; *T.m.*, teres major; *S.m.* serratus magnus; *Tr.*, trapezius, cut; *Sc.*[1], *Sc.*[2], scaleni; *T.c.*, transversalis cervicis, "its anterior slip;" *Sp.*, splenius; *L.s.*, levator scapulæ; *L.h.*, levator humeri; *B.a.*, brachialis anticus; *E.c.r.b.*, extensor carpi radialis brevior, "and origin of longior;" *E.c.d.*, extensor communis digitorum; *E.o.m.*, extensor ossis metacarpi pollicis; *E.m.d.*, extensor minimi digiti; *E.c.u.*, extensor carpi ulnaris; *F.c.u.*, flexor carpi ulnaris; *D.*, deltoid.